O P I N I O N

By Prof. Dr. Zlatinka Svetoslavova , Institute of Mathematics and Informatics at
the Bulgarian Academy of Sciences,
member of the scientific jury, according to Order No 276/6.11.2024 of the
Director of the Institute of Information and Communication Technologies at the
Bulgarian Academy of Sciences

SUBJECT: PhD Thesis of **Petar Rumenov Zhivkov** on topic: „**MODELING
THE STATE OF AIR QUALITY BASED ON HEALTH AND ECONOMIC
ASPECTS**", presented for awarding the educational and scientific degree
"Doctor of Philosophy" in a doctoral program „Informatics", **Professional field:
4.6. Informatics and Computer Sciences**, with a scientific advisor Prof. Dr. of
Science Stefka Fidanova

1. General description

At the first meeting of the scientific jury, held on 11.11.2024, I was chosen
to prepare an opinion and received the following documents:

- Thesis;
- Abstract in Bulgarian and in English;
- Curriculum Vitae;
- Copy of diploma for completed higher education (educational -
  qualification degree "Master")
- Certificate of fulfillment of the minimum requirements of IICT-BAS
  for acquiring the educational and scientific degree "doctor"
- Other documents, supporting the procedure.

2. Actuality, purpose and tasks of the PhD dissertation

The quality of atmospheric air, and more specifically the presence of fine
particulate matter in it, is a particularly relevant problem these days due to the
consequences for the health and work capacity of millions of people around the
world. In our country, especially in the capital and large cities, the levels of fine
particulate matter often exceed the norms set in the European Union. This calls
for urgent action to address the problem, including comprehensive research
efforts and the application of a scientific approach.

The goal of the dissertation work is to study the influence of fine
particulate matter on acute diseases in Sofia and to find methods of prevention.

To achieve this goal, the following tasks are set:

- Investigate the relationship between fine particulate matter and health indicators for acute morbidity in Sofia;
- Improve data from citizen air quality monitoring stations through calibration using a machine learning-based method;
- Develop a software tool for optimizing and evaluating cycling routes by characterizing cyclists' exposure to air pollution;
- Develop an IoT platform for aggregating and modeling air quality sensor data.

3. **General characteristics of the dissertation work**

The dissertation is written in Bulgarian, on 119 standard printed pages. It consists of a title page, table of contents, list of tables, list of figures, six chapters and a bibliography containing 108 titles. A list of 4 publications on the topic of the dissertation (one of which with SJR) and lists of scientific-applied and applied contributions are presented.

Chapter 1 is introductory. The actuality and motivation for the development of the subject are presented. The goals and tasks of the dissertation work, as well as the research methodology, are formulated.

In Chapter 2, the relationship between fine particulate pollution and health indicators of acute morbidity according to the World Health Organization air quality guidelines is being investigated. Based on time series analysis with correlation methods, a model of the interrelationship of air quality indicators and health problems of the population was developed. The obtained results show a significant correlation of cardiovascular and cerebrovascular diseases with the level of pollution with fine dust particles. The highest correlation is observed in acute upper respiratory tract infections.

Chapter 3 is devoted to methods for improving the data obtained from stations with laser sensors for fine particulate matter. A two-step calibration model based on machine learning is presented that improves the quality of data collected by laser stations. For this purpose, an artificial neural network of the multilayer perceptron type is used. As a result of applying the model, anomalies in sensor behavior are detected and removed from the data set.

In Chapter 4, a software model is developed for the selection of a cycling route in view of fine particulate matter pollution. In the city of Sofia, known for its high levels of air pollution, there is a lack of a comprehensive method for assessing and quantifying the level of exposure of cyclists, which hinders the provision of healthier cycling routes. For this purpose, a software model was created, which aims to select an optimal cycling route between 2 set points, ensuring the smallest dose of inhalation of fine particulate matter. The presented model was evaluated through a real-world field testing in Sofia and examination of two cycling routes.

Chapter 5 presents a complex software system that allows collection, processing and modeling of air pollution data. A cloud infrastructure is used to store pollutant concentrations, meteorological and other data coming from various sources. This enables the processing of large volumes of data and the provision of services that require flexibility and scalability.

Chapter 6 contains a conclusion, a description of the contributions and publications on the dissertation topic.

4. Contributions of the dissertation work

I accept and positively evaluate the scientific-applied and applied contributions presented in Chapter 6.

The scientific-applied contributions include:

- A statistical correlation analysis between air pollution and hospital and emergency admissions;
- Development of an algorithm for calibrating laser sensors using a two-step method with artificial neural networks and anomaly detection;
- Development of an algorithm that evaluates the influence of humidity, altitude and atmospheric pressure on air pollution data from laser sensors;
- Development of an algorithm for calculating the optimal path for a cyclist to pass, based on the concentration of fine particulate matter.

Applied contributions include software development and an IoT platform for aggregating and analyzing air quality sensor data.

The results of the PhD student's work have a great practical application for improving the quality of life and reducing morbidity in Sofia, caused by the increased levels of pollution with fine particulate matter. The chosen research methodology, as well as the technologies used, correspond to the set goals and objectives.

5. Abstract

The submitted abstract in Bulgarian and English reflects correctly and in sufficient detail the content of the dissertation work and corresponds to the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the regulations for its application. The abstract is written on 55 printed pages and gives a clear idea of the investigated problems, the obtained results and the contributions of the dissertation work.

The personal participation of the PhD student in the contributions and the in-depth knowledge of the topic is evident from the presented publication activity and from the declaration of originality..

6. Assessment of compliance with minimum national requirements

The minimum national requirements for obtaining the educational and scientific degree "Doctor" in the professional field 4.6. "Informatics and computer sciences", defined in the Law on the Development of the Academic Staff in the Republic of Bulgaria, as well as the Regulations for the terms and conditions for acquiring scientific degrees and for holding academic positions at IICT-BAS, include the presence of at least 30 points from Group indicators G.

The PhD student Petar Rumenov Zhivkov has fulfilled these requirements, as he has submitted 4 publications carrying 32 points. Two of the publications are indexed in Scopus, one of which is with SJR.

7. Notes and recommendations

A small number of typing errors are noted which do not affect the overall positive performance and contributions of the PhD student.

I recommend that the publication activity of the PhD student be strengthened, as a large volume and useful in content work has been carried out, which deserves greater representation in scientific forums and journals.

8. Final comprehensive assessment

I believe that the presented dissertation meets the set of criteria and indicators for the acquisition of the educational and scientific degree "Doctor" according to the Law on the Development of the Academic Staff, the Regulations for its application and the Regulations for the conditions and procedures for the acquisition of scientific degrees at IICT-BAS. A considerable volume and content of research work has been carried out. There is a sufficient number of scientific and scientific-applied contributions. A sufficient number of publications reported at prestigious scientific forums are presented. This gives me reason to convincingly recommend to the Scientific Jury to propose to the honorable Scientific Council to award the PhD candidate Petar Rumenov Zhivkov the educational and scientific degree "Doctor" in the field of higher education: 4. Natural sciences, mathematics and informatics, Professional field: 4.6. "Informatics and Computer Science".

20/01/2025
Sofia

Prej
(Pro

На основание

331Д